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Digital media in education: Expanding the technology acceptance model

Heidi Huntington

The Rochester Institute of Technology

Department of Communication

College of Liberal Arts

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by

Heidi E. Huntington

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The members of the Committee approve the thesis of
Heidi E. Huntington presented on July 18, 2011

_____

Tracy R. Worrell, Ph. D.
Assistant Professor of Communication
Department of Communication
Thesis Adviser

_____

Michael Yacci, Ph. D.
Professor of Information Sciences
& Technology
B. Thomas Golisano College of Computing
& Information Sciences
Thesis Adviser

_____

Rudy Pugliese, Ph. D.
Professor of Communication
Director, Communication & Media
Technologies Graduate Degree Program
Department of Communication

_____

Patrick M. Scanlon, Ph. D.
Professor of Communication and Chair
Department of Communication

DIGITAL MEDIA IN EDUCATION: EXPANDING THE TECHNOLOGY ACCEPTANCE MODEL

Name: Heidi E. Huntington
Department: Communication
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Abstract

Studies show that use of computer-based information communication technologies (ICTs) can have positive impacts on student motivation and learning. The present study examines the issue of ICT adoption in the classroom by expanding the technology acceptance model (TAM) to identify factors that contribute to teacher acceptance and use of these technologies in the classroom. A survey was conducted of 57 high school teachers from around the United States. Results show that the variables of teacher belief profile and teacher efficacy can determine high school teacher acceptance of these technologies, when added to the TAM. Additionally, the study confirms previous research that indicates perceived media richness as an important variable to consider in TAM studies of digital media and ICTs.

Keywords: Technology Acceptance Model, education, media richness, teacher, information communication technologies

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Digital Media in Education: Expanding the Technology Acceptance Model

Throughout the history of the study of mass media, the introduction of each new medium has been "accompanied by anxiety about its imagined effect on less educated, often 'vulnerable' social groupings" (Sefton-Green, 2006, p. 280) — often children and young people. Early studies of a new medium regularly focus on the medium's deleterious effects on users or viewers. As time passes, studies eventually shift to an approach that examines how people adopt a technology or medium for use as a tool to reach a goal — often a more positive outlook. The same pattern appears to be true of contemporary studies of "new" digital media technologies, especially as they relate to education. For example, video games — including their role in education —became a popular research topic beginning in the 1980s. Provenzo's (1991) study of Nintendo critiqued anti-social aspects of game playing, and continued a tradition that took a "highly proscriptive view toward the place of popular culture in education" (Sefton-Green, 2006, p. 285). Meanwhile, James Paul Gee's 2003 book, *What Video Games Have to Teach Us About Learning and Literacy*, explored gaming as an arena for theorizing about learning and the semiotic process and positioned the gamer as an active reader of the game's messages (Sefton-Green, 2006, pp. 290-291).

As young people become increasingly exposed at a younger age to digital media and information communication technologies (ICTs) such as instant messaging, social networking websites, text messaging, and other Web 2.0 applications, what — if anything — is the impact on learning and the traditional classroom? As hundreds of anecdotes, folk tales, and clichéd sayings can attest, children are willing and open to trying new ideas, and as such often pick up new media and technologies much more quickly than adults. Many children today learn to boot

a computer or take a picture with a digital camera at nearly the same time they are learning to walk, talk, and process the world around them. By the time these children arrive at a traditional educational environment, their digital media abilities often outpace those of their teachers. Alvermann (2004) explains that for today's youth, being "a participant in the 21st century equates to being literate in media and ICTs in ways that exceed what many of their classroom teachers know or even consider worth knowing" (p. 78). To Alvermann, digital technologies have significant implications for educators as these technologies have fundamentally altered how ideas are represented. There is promising evidence for the effectiveness of instruction that incorporates new media and other information communication technologies, but to date there has been little empirical research on the topic, though that is slowly changing (Alvermann, 2004; Plester & Wood, 2008; Greenhow & Robelia, 2009).

Many theories have been advanced in attempts to explain the factors at work in individual's adoption and use of new technologies. The most-researched of these is the technology acceptance model (TAM; Davis, 1989), which has repeatedly been empirically proven to consistently explain antecedents to intention to use a technology or information system across populations and technologies (Anandarajan, Zaman, Dai, & Arinze, 2010; Venkatesh, Morris, Davis, & Davis, 2003; Liu, 2010; Yuen & Ma, 2008). It is a robust model, and open to further testing with different populations and variables. Another theory that attempts to address factors related to technology acceptance and media choice is media richness theory (MRT). MRT has been proposed to assess a communication medium's "capacity to facilitate shared understanding" (Anandarajan et al., 2010, p. 133). Richness of various media used in education has been shown to have both positive and negative impacts on learning (Mayer, Hegarty, Mayer,

& Campbell, 2005; Mayer, Griffith, Jurkowitz, & Rothman, 2008; Clark & Mayer, 2008). This study will attempt to expand the technology acceptance model and media richness theory to include determinants to educators' acceptance and successful adoption of digital media as tools in the classroom.

Literature Review

Studies of media effects on young people and young people's uses of media are not new. Still, the effects of new media on the education and learning of young people specifically is a research area that is relatively young — as are new media. Many studies in this area are either ethnographic studies of a specific population, or proposals for future research topics. Some studies seek to understand students' attitudes toward and perceptions of new media in the classroom, while a few others focus on the impact new media have on educators. A few studies have sought to highlight characteristics that differentiate between teachers who successfully adopt new technology in the classroom and those who do not (Tondeur, Hermans, van Braak, & Valcke, 2008; Tondeur, Valcke & van Braak, 2008; Yuen & Ma, 2008; Mueller, Wood, Willoughby, Ross, & Specht, 2008). Studies have applied TAM and MRT across populations and various technologies, from Gen Y acceptance of instant messaging (Anandarajan et al., 2010) to the adoption of educational wikis (Liu, 2010). Certain studies seek to establish methods to compare content in traditional educational media and new educational media. Others warn of the dangers of incorporating new media in education without teaching children proper media literacy techniques.

This literature review will be divided into three subsections:

• Young people, digital media and education: Outlines a brief history of studies conducted of children and media and those studies which sought understanding of students' attitudes toward new media and the Internet in the classroom.

• Theoretical framework: Studies relevant to the development of the technology acceptance model and media richness theory, along with the models' application to the field of education will be discussed.

• Digital media and the impact to educators: Outlines some studies presenting challenges for educators in attempting to incorporate new media in the classroom. Studies attempting to detail educator attitudes toward new media and factors concerning educator adoption of digital media technologies in the classroom will also be addressed**.** Some studies have sought to compare content of educational materials presented in both traditional and new media formats. A few such studies will also be discussed here.

Young People, Digital Media and Education

Arguably, digital media present knowledge in a manner different from traditional printed media, or even television, and as such transform traditional ideas of literacy and knowledge (Livingstone, 2003, p. 154). Livingstone argues that because literacy provides social power, it is important to examine changing conceptions of knowledge and learning to provide young people with the best education possible, and to provide a cultural and historical framework for the world of digital media in which young people are now immersed. Similarly, Plester and Wood (2009) posit that if today's young people are to be full participants in the digital world they will inhabit as adults, they must be taught to "decode information in various orthographic formats" (p. 1109).

In the future, literacy will mean more than being able to read, write and solve basic math problems. In fact, children from low-income families who may not be able to participate in digital media and Web 2.0 technologies as much as their more-affluent peers will be at a disadvantage once they grow up and attempt to enter the workforce (Greenhow & Robelia, 2009). As such, it is increasingly important to examine the manner in which digital media and new ICTs are addressed in the classroom.

A research subset of note examines new media and early childhood literacy. Wohlwend (2009) conducted a three-year ethnographic study of children's literacy play in primary school classrooms and found that children fashioned pencil and paper resources into representations of new media, such as iPods, cell phones and video games, to enhance group play when the actual objects themselves were not at hand. The study concluded that children are quick to cue in to features of cultural importance in everyday life. When educational institutions are slow to adopt these technologies, children will find a way around the barrier. A study of "early" new media was conducted by Smith (2002), and examined the connections between technology, play and literacy her 2 ½ -year-old son, James, encountered as Smith taught him to interact with CD-ROM storybooks. Smith found that the different "storybook experiences combined to create the whole of his storybook knowledge, and his definition of story expanded. 'Story' became something that James read, created, and did" (p. 7). Smith also contends that play associated with computer use involves the use of language and contributes to the development of new understandings.

As new media break down barriers between active and passive aspects of children's play experiences — as in the case of James' storybooks — what might be the effect in the classroom as these digitally literate children enter traditional school settings? Havelock (1982) posits that

the invention of the Greek alphabet around 700 B.C. changed "the content of the human mind" (p. 56) by creating a visual record of thoughts that previously had to be memorized. By releasing the burden of memorization, the human mind became free to ponder the unexpected, directly producing the leaps in human knowledge and advancement seen during this time (p. 57). If the transition to print literacy had such a profound impact on the human mind, might the transition to digital literacy produce similarly significant impacts on human learning and knowledge? Plester & Wood (2009) examined text messaging among British pre-teens and found that texting may contribute to the overall literacy development in positive ways. Similarly, Greenhow & Robelia (2009) found that the use of MySpace reinforced high school students' traditional literacy skills. In both studies, researchers noted that students did not see an overlap between such "in-school" and "out-of-school" literacy practices, but positive reinforcement of the one on the other was empirically proven by the researchers.

Levin and Arafeh's 2002 study, conducted for the Pew Internet and American Life Project, uncovered insights into the attitudes of then current middle- and high-school students toward Internet use in the classroom. The article is particularly valuable in that it asks students directly about their Internet use, both in and out of the classroom. The authors write that in 2002, 30 to 40 percent of teenagers fell in to the Internet-savvy category, representative of "a large and growing cohort of technologically-elite students" (p. 4). In 2002, students already depended on the Internet to do schoolwork and could not imagine life without it. Many students turned to the Internet as a tutor for help understanding difficult subjects (p. 10), and wanted more opportunities to connect with teachers via e-mail and instant messenger (p. 11). One middle-school girl is quoted: "Our textbooks are no longer the pillar, the heart of our education. On the

contrary, they are a laughable supplement most of the time ignored" (p. 7). Some of the main conclusions of the study were that students wanted better coordination of out-of-school educational use of the Internet with classroom activities and better quality of access to the Internet in school (p. 23). Students also believed that teachers should receive professional development and technical assistance to effectively integrate the Internet into curricula (p. 23).

Selwyn (2006) attempted to replicate Levin and Arafeh's study to assess attitudes of students in the U.K. regarding implementation of the Internet in school. Selwyn writes that students in the U.K. seemed to take a more measured approach to perceived less-than-perfect IT implementation, seeing spotty implementation as more of an inconvenience than as a disaster, as the U.S. students seemed to in Levin and Arafeh's study (p. 14). The author speculated that this may be a function of the U.K. study being conducted four years later than the U.S. study, as well as the fact the U.K. government had recently undertaken initiatives to improve the quality of information technology in schools.

Theoretical Framework

The technology acceptance model (Davis, 1989) focuses on user acceptance of computer-based technologies and states that an individual's perceived usefulness (PU) and perceived ease of use (PEU) of a technology are determinants of that individual's intention to use the technology. Though the model is robust and has high validity across numerous studies, it is still open to the addition of other variables that can influence and affect adoption of a certain technology (Liu, 2010; Venkatesh et al., 2003; Liu, Liao & Pratt, 2009; Yuen & Ma, 2008; Anandarajan et al., 2010). The model has most often been applied in business or organizational contexts (Venkatesh et al., 2003). In the field of education, TAM and additional variables have

been applied to explore varying technologies. In a study regarding in-service teacher acceptance of e-learning technology in Hong Kong (Yuen & Ma, 2008), subjective norm and computer self-efficacy were found to significantly determine perceived ease of use and intention to use the e-learning technology. Liu (2010) provided support for self-efficacy as a predictor of perceived ease of use and perceived usefulness in the adoption of educational wikis by college-age students.

Another theory often applied to acceptance of technology in an educational context is media richness theory, a theory most often applied to study of media choice. Media richness is described as the ability of a medium to achieve shared understanding between parties in a given amount of time (Anandarajan, 2010; Robert & Dennis, 2005; Sun & Cheng, 2005; Chen, Yen, Hung, & Huang, 2008; Dennis & Kinney, 1998). MRT was originally a prescriptive model, meant to explain which media were best suited to a specific task. With the advent of new digital media, the model has evolved to describe how individuals match media to a task (Robert & Dennis, 2005). Perhaps because of evidence linking lesson details to learning outcomes (Mayer et al., 2008; Mayer, et al., 2005; Clark & Mayer, 2008), MRT has been used in the literature in combination with the technology acceptance model as a variable to explain acceptance or adoption of media used in an educational environment. Sun & Cheng (2007) applied MRT to the design of instructional multimedia and found that use of high-richness media in courses with more equivocal subject matter has a significant positive effect on learning score and student satisfaction, more so than low-richness media (p. 672). However, high-richness media did not have a significant difference on learning score or satisfaction in courses with subject matter of low equivocality, emphasizing the importance of media choice by educators in

the classroom. Liu, Liao & Pratt (2009) confirm the influence of media richness as an external variable on intention to use e-learning technology. The authors speculate that increased media richness enhances individuals' perceptions of usefulness (p. 606).

MRT has also been combined with TAM in areas not specifically related to education. In their study of instant messaging adoption among members of Generation Y, Anandarajan et. al. (2010) propose a construct of "use richness" — how much users employ a technology's various features to achieve shared understanding in communication. Their study concluded that perceived media richness of a technology has a positive effect on use richness of that technology. The more study participants believed IM to facilitate shared understanding in communication, the greater use they made of the IM program's various features. Additionally, the study demonstrated that perceived ease of use of a technology significantly and positively affects perceived usefulness and perceived social usefulness of using that technology, which together significantly and positively impact use richness. Yu, Tian, Vogel & Kwok (2010) found that among university students, social acceptance through the use of social networking sites had positive influence on learning outcomes, indicating that social usefulness can be seen as a variable related to technology acceptance, at least among students and young people.

Though social usefulness can be an important variable in the study of technology adoption for educational purposes by students, it may not be applicable in the context of teacher adoption of computer-based ICTs in the classroom, as for teachers the classroom is a place of business. However, another variable that has been found effective as a predictor of technology adoption among students and teachers alike may be a better fit to help explain teacher adoption and use richness of these technologies in the classroom: self-efficacy, or more specifically teacher

efficacy (Yuen & Ma, 2008; Liu 2010). Teacher efficacy is an extension of self-efficacy, and can be generally defined as the extent to which a teacher believes he or she can influence student achievement, or a teacher's belief about his or her capacity to perform to certain standards (Tschannen-Moran, Hoy & Hoy, 1998, pp. 202-203).

Digital Media and the Impact to Educators

With children becoming extremely digitally literate at an increasingly early age, when they arrive in school their abilities begin to outpace those of their educators. While some early childhood educators have ready access to appropriate new media technologies and willingly incorporate them in the classroom, over 50 percent of primary school educators self-identify as technology novices (in Wohlwend, 2009, p. 118). In many cases equipment — when available — remains a mere accessory for entertainment, while the legitimate curriculum is administered through traditional methods such as paper and pencil (Wohlwend, 2009, p. 118). There has also been much discourse in the research about the proper place of new media technologies in the classroom. According to Alvermann, some teachers still contend that the relevancy of new media to achieving success in school is marginal at best, while others argue that if teachers continue to ignore the impact information communication technologies have on today's students, they will fail to gain insights that can be learned from tapping into that digital literacy (2004, pp. 80-81).

Some studies have sought to explain determinants to the use of computers in the classroom by teachers. Mueller et. al. (2008) conducted a survey of 185 elementary and 204 secondary school teachers in Canada. They found that, with more widespread availability of new technologies, environmental factors were no longer much of a consideration, but that positive

attitudes toward and experience with technology are indicators of teachers who "successfully" adopt technology for use in the classroom. Attitude is a variable that has been applied to the technology acceptance model, though there is some mild disagreement in the literature over its place. Teo's 2009 survey of 442 pre-service teachers in Singapore found that attitude toward computers did not contribute toward use variance. However, Venkatesh et al. (2003) found attitude toward computers to significantly predict intention to use a technology, particularly in voluntary settings.

This distinction may be important in the study of teacher acceptance and adoption of technology in the classroom. Tondeur, Hermans, et al. (2008) outlined a connection between teacher educational beliefs and use of information communication technologies in the classroom and suggest that when it comes to adoption of technology in the classroom, teacher beliefs are closely tied to action. In this context, teacher beliefs are defined as "an eclectic mix of rule of thumb, generalizations, opinions, values and expectations that underlie teachers' planning, decision making and behavior in the classroom" (Tondeur, Hermans et. al., 2008, p. 2543). The study used scales developed by Woolley, Benjamin, & Woolley (2004) to link constructivist teaching and traditional teaching belief profiles to classroom computer use, and determined that teachers with a higher constructivist — or student-centered — teaching belief profile tend to make more use of computers in the classroom.

Some studies focus on student perceptions of new media in the classroom in terms of the impact these perceptions may have on teacher credibility and, by extension, student motivation to learn. As social media deconstructs walls of privacy and boundaries between the professional and the personal, educators may find that personal revelations through social media out of the

classroom can have an effect in the classroom. Mazer, Murphy & Simonds (2007) studied the effect of professor self-disclosure on Facebook on student motivation and perceptions of classroom climate. Their study found that students rated a professor more favorably after viewing a Facebook profile of the professor that was high in self-disclosure than students who viewed a Facebook profile of the same professor that was low in self-disclosure. Another study of the effects of computer-mediated communication on professor credibility focused on the effects of computer-mediated word-of-mouth messages on student perception of professors. Edwards, Edwards, Qing & Wahl (2007) conducted an experiment to determine the effects of websites such as RateMyProfessors.com on students' attitudes toward a professor and a course. The study found that "students who receive positive computer-mediated WOM [word-of-mouth communication] about an instructor perceive the instructor as more credible and more attractive than students who receive negative computer-mediated WOM about the instructor or none at all" (p. 265).

From the literature, it can be seen that the question of the effect of new, digital media on learning, literacy and education is one that is of importance to the ability of today's children to be fully functioning and contributing adults in tomorrow's digital society. Many researchers have conducted studies related to media's impact on learning and literacy, student motivation and perception of teacher credibility (Edwards, Edwards, Qing & Wahl, 2007; Mazer, Murphy & Simonds, 2007), but participants in these studies are often instructors or students in higher education. Levin and Arafeh (2002) conducted a study of middle- and high-school students' perceptions of the success of Internet use implementation in schools. However, this study was

conducted roughly ten years ago, and there have been many changes and growth in the reach of ICTs since then.

Some studies have examined the technology acceptance model and media richness theory in the context of secondary school education. Still others have examined differences among teachers who adopt technology in the classroom and those who do not. However, these latter findings have not yet been connected to TAM and MRT, and to date, none of these studies have been conducted in the United States. There is a place for a study examining these phenomena among high school educators using a theoretical framework.

Literacy and learning are perhaps at their core social problems to be solved. When it comes to studying media and literacy learning outcomes, Anderson and Hanson (2009) contend that in the same way the impact of print media on literacy has been studied extensively, causing print literacy to be recognized by the government as national policy, electronic media's impact on literacy should be studied (p. 1204). Additionally, some research indicates that a digital gap is developing between social classes (Greenhow & Robelia, 2009). In order for today's children to be fully equipped to participate in society as adults, it is necessary for the new digital technologies to be fully incorporated in the classroom. By applying empirical research methods to study factors relating to teachers' acceptance of technology in the classroom, the present study hopes to outline factors at play in the inclusion of such technologies in the classroom.

Research Questions

The present study proposes to test and expand the technology acceptance and use richness model developed by Anandarajan et al. (2010) in order to attempt to explain teachers' perceptions regarding and variables influencing adoption of digital media information

communication technologies for use in the classroom. Tondeur, Hermans, et al. (2008) conducted their study of teacher computer use in Flanders, and found that information communication technology use is "mediated by teachers' beliefs about teaching and learning" (p. 2550) and that teachers whose beliefs fit certain profiles are more likely to adopt new ICTs for use in the classroom. Additionally, the Anandarajan study noted that perceived media richness was a variable influencing adoption of a new technology. As discussed, richness of media can impact learning outcomes, therefore:

> RQ 1: What is the relationship between teachers' beliefs about teaching and learning and teachers' perceived media richness of computer-based information communication technologies when used as educational tools in the classroom?

The Anandarajan study identified social usefulness as a factor influencing adoption of a new technology (IM) among young people. In the study of educators, the concept of teacher efficacy is perhaps more suited to the task than is the concept of social usefulness. The concept of teaching efficacy encompasses a teacher's beliefs regarding his or her own effectiveness and teaching ability. Mueller et al. (2008) noted that teaching efficacy did not have a significant impact on determining those teachers who successfully integrated technology in the classroom; however, the authors noted that the scale used in that study referred only to teaching in general and speculated that perhaps it should have been specific to computer technology use in the classroom. In contrast, Liu (2010) found that students' self-efficacy using educational wikis was positively related to perceived ease of use and perceived usefulness. Will focusing attention to teaching efficacy while using these ICTs as educational tools in the classroom make a difference?

RQ 2A: What is the relationship between teachers' beliefs about teaching and learning and teachers' perceived teacher efficacy when using computer-based information technologies as educational tools in the classroom?

Perceived media richness, perceived ease of use and perceived usefulness are other variables that were shown to positively affect perception of use richness in the study Anandarajan et al. (2010) conducted regarding IM acceptance among young people belonging to Generation Y. Could we then expect to see a relationship between teacher belief profiles, perceptions of teacher efficacy while using computer-based, digital media ICTs in the classroom and perceived use richness of those technologies? And what are the relationships between the different variables?

RQ 2B: What is the relationship between teachers' perceptions regarding teacher efficacy while using computer-based information technologies as educational tools and teachers' perceived ease of use and perceived usefulness of those technologies?

RQ 3: What is the relationship between teachers' belief profiles regarding teaching and learning and teachers' perceived use richness of computer technologies used in the classroom?

RQ 4: What is the relationship between teachers' perceptions regarding teacher efficacy while using computers in the classroom and teachers' perceived use richness of those technologies?

RQ 5: What is the relationship between teachers' perceived ease of use and perceived usefulness of computer technology in the classroom and perceived

media richness of that technology?

Methods

Two types of sampling methods were used to create a sample population of high school teachers from around the United States. Participants responded to an online survey consisting of a series of scales operationalizing each variable, some basic demographic information and an open-ended discussion question.

Participants

Participants were teachers in high schools throughout the United States. Through a combination of snowball sampling and known-group sampling, a population of 57 respondents was obtained. Participants were nearly evenly split between the sexes (males $N = 27$, females $N = 30$) and ranged in age from 23 years to 65 years with a mean of 37.8 years ($SD = 11.2$). Survey respondents taught in six states: New York (49.1%, $N = 28$), Colorado (28.1%, $N = 16$), Texas (10.5%, $N = 6$), Wisconsin (7%, $N = 4$), Ohio (3.5%, $N = 2$) and Maryland (1.8%, $N = 1$). Additionally, respondents taught at all high school grade levels, with many teaching courses for more than one grade level (9^{th} $N = 35$, 10^{th} $N = 46$, 11^{th} $N = 47$, 12^{th} $N = 49$).

Procedure

After obtaining institutional review board approval, survey responses were collected over the course of five weeks in the spring of 2011. The anonymous survey was digitized and hosted online through a Northeastern university's survey service. A link to the secure online survey and a brief introduction were sent via e-mail to principals of schools to pass on to faculty, as well as posted online via Facebook and other similar sources. Survey participants were asked to forward the link to the online survey to colleagues they thought might also be interested in taking the

survey. Sample invitation text was given to respondents at completion of the survey for this purpose. After this snowball group sampling proved to produce minimal respondents, known-group sampling was also introduced and conducted alongside the snowball sampling method. Teachers were contacted directly by e-mail addresses available online via school staff directories with a brief introduction to the study and an invitation to learn more by visiting the provided link.

Design

Survey responses were collected anonymously, and participants were not asked to provide indentifying information beyond some basic demographic information, such as age, gender and state in which he or she taught. Prior to beginning the survey, respondents were required to read and agree to an informed consent notice. The survey instrument consisted of a series of scales previously tested in other studies to measure the variables of teacher beliefs, teacher efficacy, perceived ease of use, perceived usefulness, media richness and use richness. While these scales have been used and tested in earlier studies, it is believed that the scales have not been used together in this manner in previous research.

Teachers' beliefs about teaching and learning were operationalized using modified versions of scales developed by Woolley, Benjamin, & Woolley (2004) in their Teacher Belief Survey. These scales for Constructivist Teaching (CT) beliefs and Traditional Teaching (TT) beliefs had a Cronbach's alpha of .78 (TT) and .73 (CT). These same scales were used in the Tondeur, Hermans, et al. (2008) study and were found there to have a Cronbach's alpha of .74 (TT) and .68 (CT). Items on the TT scale include: "To be sure that I teach students all necessary content and skills, I follow a textbook or workbook" and "I base student grades primarily on

homework, quizzes, and tests." Items on the CT scale include: "I believe that expanding on students' ideas is an effective way to build my curriculum" and "I prefer to assess students informally through observations and conferences." Participants were asked to respond to each statement on a 5-point, Likert-type scale, with 1 = "totally disagree" and 5 = "totally agree."

The variable of teacher efficacy was operationalized using a shortened version of the Teacher Efficacy Scale (in Tschannen-Moran, Hoy & Hoy, 1998). The scale asks for answers to questions such as, "The amount a student can learn is based primarily on family background" and "If I try really hard, I can get through to even the most difficult or unmotivated students" on a 5-point Likert-type scale. This scale was also used in the 2008 Mueller et al. study, where it had a Cronbach's alpha of .77. To direct respondents' attention to teacher efficacy while using digital media technology in the classroom, additional questions were added to the scale for the present study. These questions were adapted from the measure of different types of computer use created by Tondeur, et al. (2007) — "basic computer skills," "computers as information tool" and "computers as learning tools." Liu (2010) notes that previous research indicates that self-efficacy scales have better predictive value when used in a particular context (p. 54), so it is appropriate to create one's own scale as needed.

Perceived ease of use (PEU) and perceived usefulness (PU) were operationalized using scales adapted from Davis (1989). These scales have been validated many times; in Davis' study they had a reliability of .98 (PU) and .94 (PEU). Questions included, "I find it easy to get these applications, programs and technologies to do what I want them to do" and "I find these Web 2.0 applications and other computer technologies useful for my job as a teacher." Perceived media richness and perceived use richness were operationalized using measures adapted from

Anandarajan, et al. (2010). The measures had composite reliabilities of .72 (media richness) and .79 (use richness) in that study. The scales were presented as a 5-point, Likert-type scale. Some wording was modified to reflect the focus of the present study. Sample questions include, "Allow me to tailor messages (lessons) to my own personal requirements" and "I adapt my use of these technologies in the classroom depending on which class or subject I am teaching." The scales used in the present study can be found in Appendix A.

Results

Teacher Belief Profile and Perceived Media Richness

To address RQ 1, which asks about the relationship between teachers' belief profiles and perceived media richness of computer-based ICTs in the classroom, separate composite scale indexes for each variable (teacher belief profile and media richness) were created for each respondent by taking the mean of respondents' answers to the questions in the relevant scales. In the case of the teacher belief profile variable, separate indexes were calculated for the constructivist teaching profile (mean = 3.95, *SD* = .47) and the traditional teaching profile (mean = 3.22, *SD* = .52). A teaching belief index of 5.0 would mean the respondent had selected "totally agree" in response to all items on the scale, indicating a complete identification with the particular belief profile. The highest individual constructivist teaching belief profile index score was a 4.8, while the lowest score was a 2.8. The traditional teaching belief profile scores yielded a larger range, with the maximum score being a 4.4 and the lowest a 1.8. Composite indexes were also calculated for the variable of perceived media richness (mean = 3.21, *SD* = 1.09). Again, a score of 5.0 indicated complete agreement with all questions in the scale. The highest individual index score for the variable of perceived media richness was a 5.0, the lowest a 1.0.

An ANOVA was performed to test for evidence of a linear relationship between the variables. The ANOVA showed that there is evidence of a linear relationship between the variables of constructivist teacher belief profile and perceived media richness (F = 9.61, sig. = .003). The ANOVA showed there to be little evidence of a linear relationship between traditional teacher belief profile and perceived media richness (F = .176, sig. = .677). Next, a Pearson correlation coefficient was calculated (see Figure B1) between the variables of constructivist teacher belief profile and perceived media richness (r = .427), and another for the traditional teacher belief profile and perceived media richness (r = -.064) variables. The correlation between constructivist teacher belief profile and perceived media richness is statistically significant at the .01 level (sig. = .003, two-tailed). These results demonstrate that as a teacher identifies more closely with a constructivist teaching belief profile, his or her perception of the media richness of digital media technologies used in the classroom also increases. However, the results also indicate that a teacher's identification with a traditional teaching belief profile has little correlation to his or her perception of the richness of these digital media when used in the classroom.

Teacher Belief Profile and Teacher Efficacy

To calculate the relationship between teacher belief profile and teacher efficacy when using digital media in the classroom as asked in RQ 2A, a composite teacher efficacy scale was created for each respondent (mean = 3.71, SD = .418). A score of 5.0 would indicate the respondent believed him- or herself to be totally effective in all the situations presented in the scale. The highest score was a 4.6, the lowest a 2.8. The indexes for constructivist teaching belief profile (mean = 3.95, SD = .47) and traditional teaching belief profile (mean = 3.22, SD =

.52) calculated to address RQ 1 were also used here. Again, an ANOVA showed evidence of a linear relationship between the variables of constructivist teacher belief profile and teacher efficacy (F = 8.93, sig. = .005). The ANOVA showed the linear relationship between a traditional teaching belief profile and teacher efficacy (F = 2.25, sig. = .141) is not as strong, or statistically significant. A test of the Pearson correlation coefficient yielded a positive correlation between a constructivist teaching belief profile and teacher efficacy while using digital media (r = .411). This finding is statistically significant at the .01 level (.005 sig., two-tailed), indicating a positive relationship between constructivist teaching belief profile and perception of teacher efficacy while using digital media in the classroom. The Pearson correlation coefficient between traditional teaching belief profile and teacher efficacy was not statistically significant (r = -.220, sig. = .141) but gives evidence of a slight negative correlation.

Teacher Efficacy, Perceived Usefulness and Perceived Ease of Use

RQ 2B asks about the relationship between the variables of teacher efficacy while using digital media in the classroom and teachers' perceived usefulness and ease of use of those technologies. Composite scale indexes for each variable were created for each respondent; perceived usefulness (PU) had a mean of 3.45 (SD = 1.05) and perceived ease of use (PEU) had a mean of 3.62 (SD = 1.02). The minimum score for both PU and PEU was 1.0 and the maximum for both was a 5.0. Separate ANOVAs were conducted to look for linear relationships between teacher efficacy (mean = 3.71, SD = .418) and perceived usefulness (F = 24.58, sig. = .000) and teacher efficacy and perceived ease of use (F = 12.21, sig. = .001). The ANOVAs indicate a linear relationship between the variables. When tested, the variables of teacher efficacy and perceived usefulness showed a Pearson coefficient of .559 (two-tailed sig. = .000). Teacher

efficacy and perceived ease of use of digital media technologies yielded a coefficient of .429 (two-tailed sig. = .001). Both these findings are significant at the .01 level, and indicate that positive relationships exist between a teacher's reported efficacy while using digital media technologies in the classroom and her perceived usefulness and perceived ease of use of those technologies. Additionally, previous studies (Anandarajan et al. 2010, Liu 2010) have demonstrated a positive relationship between PEU and PU of a technology. This is confirmed in the present study (r = .661, sig. = .000). Therefore, not only is teacher efficacy positively related to both PEU and PU, but perceived ease of use of a technology also is positively related to its perceived usefulness in the eyes of high school teachers.

Teacher Belief Profile and Use Richness

To examine the relationship between teacher belief profiles (constructivist mean = 3.95, *SD* = .47; traditional mean = 3.22, *SD* = .52) and those teachers' perceptions of use richness of computer-based digital media technologies in the classroom as asked in RQ 3, a composite use richness scale index was created for each respondent (mean = 3.19, *SD* = 1.15, min. = 1.0, max. = 5.0) by taking the mean as with the previous variables. An ANOVA found a linear relationship between the variables of constructivist teacher belief profile and use richness (F = 4.56, sig. = .038). The ANOVA did not indicate strong or statistically significant evidence of a linear relationship between a traditional teaching belief profile and use richness (F = .478, sig. = .49). A Pearson correlation coefficient was conducted for constructivist teacher belief profile and use richness (r = .310). These results are significant at the .05 level (two-tailed sig. = .038), indicating that a teacher with a higher constructivist teaching belief profile will report higher levels of use richness when using computer-based digital media technologies in the classroom.

The Pearson correlation coefficient between the variables of traditional belief profile and use richness (r = -.105, sig. = .493) is not statistically significant, but may indicate a slight negative relationship between the two.

Teacher Efficacy and Use Richness

RQ 4 asks about the relationship between reported teacher efficacy (mean = 3.71, *SD* = .418) while using digital media technologies in the classroom and perceptions of use richness (mean = 3.19, *SD* = 1.15) of those technologies. An ANOVA of these two variables indicates a linear relationship (F = 13.89, sig. = .000) between them. A Pearson test indicates a positive relationship (r = .456, two-tailed sig. = .000) between teacher efficacy and perceived use richness of digital media technologies. These findings are statistically significant at the .01 level.

Perceived Usefulness, Perceived Ease of Use and Media Richness

To address RQ 5, which asks about the relationship between the variables of perceived usefulness (mean = 3.45, *SD* = 1.05), perceived ease of use (mean = 3.62, *SD* = 1.02) and perceived media richness (mean = 3.21, *SD* = 1.09), separate ANOVAs were conducted to determine any linear relationship between the variables. A linear relationship exists between the variables of perceived usefulness and media richness (F = 72.02, sig. = .000) and between perceived ease of use and media richness (F = 26.97, sig. = .000). Next, Pearson coefficients for each relationship were determined; a positive relationship exists between both perceived usefulness and perceived media richness (r = .756) and perceived ease of use and perceived media richness (r = .577). Both have two-tailed statistical significance at the .01 level (.000). These results demonstrate that higher levels of perceived usefulness and perceived ease of use of these technologies result in higher levels of perceived media richness of these technologies.

Additionally, Anandarajan et al. (2010) demonstrated a link between media richness and use richness. This is upheld in the present study (r = .786).

Discussion

Research surrounding the technology acceptance model seeks to explain adoption of a particular technology by a specific population. The model itself is open to change as technologies change; in his own proposal of the model, Davis (1989) noted that it is necessary to study other variables that have an impact on TAM's variables of perceived ease of use and perceived usefulness — and in turn, adoption of new technologies. Anandarajan et al. (2010) expanded the technology acceptance model to include perceived media richness of a technology (MR) and proposed the construct of use richness to describe the quality of use adopters elicit from a technology. Other studies have outlined relationships between teacher beliefs and levels and types of computer use in the classroom (Mueller et al. 2008; Tondeur, Hermans et al. 2008), and between the variable of efficacy and adoption of technology (Yuen & Ma 2008; Liu 2010).

The present study introduces two new variables (teacher belief profile and teacher efficacy) to the technology acceptance model and confirms the finding of Anandarajan et al. (2010) and Liu, Liao & Pratt (2009) that media richness is an appropriate variable to consider when studying adoption of new digital media technologies by a population. Positive and significant relationships were found among six of seven variables in the present study, ultimately linking a constructivist teacher belief profile and higher reported levels of teacher efficacy with increased use richness in regards to computer-based digital media information communication technologies in the classroom. This relationship appears to be both direct, and indirect through influencing other variables in the technology acceptance model.

The present study demonstrates a positive relationship between the variables of perceived ease of use, perceived usefulness, constructivist teacher belief profile and perceived media richness of computer-based ICTs in the classroom. The direct relationship between the variables of PU, PEU and MR was not present in the Anandarajan (2010) study. However in their 2009 study, Liu, Liao & Pratt also demonstrated the importance of media richness as a variable determining intention to use a new learning technology among students and posited that increased media richness enhances individuals' perceptions of the usefulness of a particular technology. The present study confirms a positive relationship between the variables of PU and perceived MR, and PEU and perceived MR of a technology. These findings confirm the place of media richness as a variable in TAM studies relating to the adoption of newer digital media technologies.

Additionally, in the present study, a positive relationship was found between teachers with a higher constructivist teacher belief profile and both perceived media richness and use richness of computer-based ICTs. This supports findings by Tondeur, Hermans et al., (2008), that teachers with a higher constructivist teacher belief profile engage in more varied types of computer use in the classroom — or have greater use richness of the technology to use the construct proposed by Anandarajan et al. (2010). Results involving the traditional teaching belief profile were not statistically significant, but may indicate a slight negative relationship between a traditional teaching belief profile and the variables of teacher efficacy and use richness of the technology. Additionally, the results indicate a traditional teaching belief profile has almost no relationship to perceived media richness of these ICTs among teachers. These results indicate that while a constructivist teaching belief profile can be viewed as an attitude

determinant to teacher adoption and use of computer-based ICTs in the classroom, a traditional teaching belief profile cannot be applied in the same way. Neither does it appear based on the results of the present study that teachers who hold a more traditional teaching belief profile are inherently less likely to make use of these technologies in the classroom. These findings may indicate that these belief profiles are not necessarily exclusive of one another; teachers may hold beliefs that cross between profiles (Tondeur, Hermanns et al. 2008; Woolley et al. 2004). Though a traditional teaching belief profile is not an indication of a negative attitude toward technology, it may benefit teachers to be self-aware of their teaching belief profile, and of the effect these teaching beliefs may have upon teaching style and methods, and by extension the impact to student learning (Woolley et al. 2004, p. 328).

The present study's findings also support previous research that found efficacy influences perceived usefulness and perceived ease of use of a technology (Liu 2010; Yuen & Ma 2008). In the present study, teacher efficacy, a subset of the construct of self-efficacy that directly deals with the individual's perception of his or her own effectiveness as a teacher, is demonstrated to positively affect the TAM variables of PU and PEU. The present study also finds a positive relationship between a constructivist teacher belief profile and teacher efficacy. These two variables are both attitudinal in nature and indicate the continued importance of the role of measures of attitude or beliefs in TAM studies, especially in voluntary adoption settings (Venkatesh et al. 2003; Mueller et al. 2008). Finally, a direct positive relationship was found between teacher efficacy and perceived use richness of computer-based ICTs in the classroom, suggesting that teachers who feel more confident in their ability to teach while using computer-based ICTs also make more use of these technologies in a more varied manner in the classroom.

A model of the correlations among the variables can be seen in Figure B2.

Limitations and Future Research

The construct of use richness assumes adoption of a particular technology or technologies. The present study, in seeking to examine overall adoption of digital media in the classroom, did not ask teachers to respond in regards to one specific technology, but rather listed several as examples of "digital media technologies in the classroom." Teachers who participated in the present study were not asked to quantify how many digital media technologies they use in the classroom or how often they make use of these technologies. Additionally, surveys by nature can only measure participants' own perceptions of events. Therefore, the present study offers no objective measure of actual technology use in the classroom to which to compare these findings, nor does it address one specific technology, but rather the concept of "digital media technologies in the classroom." This is an intentional departure from typical technology acceptance studies, which focus on adoption of one specific technology. The present study is concerned with factors influencing teacher adoption of digital technology in the classroom in general; however, it is possible that the broader focus could affect respondents' answers.

An optional, open-ended question at the end of the survey asked teachers to describe any factors they felt influenced their adoption or non-adoption of computer-based digital media technologies in the classroom. Thirty-eight participants chose to answer. Many respondents who took the time to answer this particular question indicated that they did not in fact use such technology in the classroom, some because of a lack of resources, some for privacy concerns and some simply noted they did not see these technologies as necessary for learning. Common themes regarding lack of resources included blocking of applications such as Facebook and

YouTube by the school district (n = 11) and no or not enough access to computers. Respondents' answers to this open-ended question stand in contrast to the 2009 findings of Mueller et al. that environmental factors were no longer a big issue in teacher adoption of computer-based ICTs in the classroom in Canada. It would seem that in the United States, teachers still must contend with a lack of access to computer-based digital media technologies.

In their development of the Teacher Belief Scale, Woolley et al. noted that it is possible teachers' belief profiles evolve over time based upon individual experiences (p. 327). Responses to this open-ended question may bear this out, as several respondents expressed disillusionment with the "system," particularly those teachers who mentioned working in "poor" or "rural" school districts. One such respondent indicated that he believed such technologies could be an "awesome" tool if he taught in a different school district, but thought the use of technology "questionable" in his current school district. Another respondent stated that she believed many of her students in her rural school district did not even have e-mail addresses with which to sign up for Web 2.0 services or submit projects, while yet another pointed toward a lack of taxpayer funding as a hindrance to technology adoption. A longitudinal study tracking teachers' belief profiles and perceptions of other variables in the TAM could provide a clearer picture of how experiences may change teacher belief profiles and technology acceptance.

Three respondents commented on the general nature of the survey's focus as influencing their responses to some of the scales regarding media richness and use richness, as they approved of one example application listed, but not another. The mention of Facebook especially caused some hesitation for concerns regarding privacy, classroom distraction potential and appropriateness for an educational environment. Based on participants' responses, it is also

possible that some respondents who desired to use such technology in the classroom but were prevented from doing so by external factors may have answered questions to reflect the manner in which they thought they would use these technologies if they could.

Still, the present study's findings may provide a starting point for future research into adoption of specific, individual technologies in the realm of secondary education. Does the model still hold up when addressing one particular technology? Additionally, a two-pronged technology adoption study that compares perceptions of media richness and use richness with actual use and measures of media richness would serve to further expand this model, as would a study that seeks to understand actual external factors at play, such as policies at the school district level, which hinder or influence adoption of technologies.

Another limitation of the present study is the convenience sample's small size. According to the most recent data from the U.S. Department of Education's National Center for Education Statistics, there were 1,234,197 secondary teachers in U.S. public schools in the fall of 2008. In the present study, survey links were directly e-mailed to 784 teachers in addition to snowball sampling. The response rate for the present study was less than 6%, which may have affected the results. Finally, the survey was only available online; providing other options for response may gain more respondents and offer a more well-rounded picture of the state of digital media technology acceptance in the classroom in future studies.

Conclusion

The question of how best to use new computer-based ICTs in the classroom is a question that has no easy answers. While previous research has shown that new computer-based ICTs can influence learning through selection of media with varying levels of richness (Sun & Cheng,

2007) as well as through influencing student motivation and enhancing teacher credibility (Mazer, Murphy & Simonds, 2007; Edwards et al. 2007), the present study indicates that adoption of such technologies in the U.S. high school classroom is far from widespread. The present study adds to the body of knowledge in this area by identifying two variables that influence teacher adoption of these digital media technologies: teacher belief profile and teacher efficacy. In addition, the present study supports the findings of Anandarajan et al. (2010) and Liu, Liao & Pratt (2009) that media richness is a variable that has a place in the study of the acceptance of new digital technologies by confirming evidence of a relationship between perceived media richness and use richness. The present study also confirms a link between perceived ease of use, perceived usefulness and perceived media richness of technology, providing further support for the importance of including the variable of perceived media richness in future studies.

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Appendix A: Scales Used in Survey Instrument

Constructivist Teaching Belief Profile	I believe that expanding on students' ideas is an effective way to build my curriculum. I involve students in evaluating their own work and setting their own goals. I make it a priority in my classroom to give students time to work together when I am not directing them. I prefer to assess students informally through observations and conferences. I make it easy for parents to contact me at school or home.
Traditional Teaching Belief Profile	I believe that students learn best when there is a fixed schedule. I teach subjects separately, although I am aware of the overlap of content and skills. To be sure that I teach students all necessary content and skills, I follow a textbook or workbook. I base student grades primarily on homework, quizzes, and tests. For assessment purposes, I am interested in what students can do independently.
Teacher Efficacy	The amount a student can learn is based primarily on family background. I allow my students to use the computer in class to learn something new. If parents would do more for their children, I could do more. If I really try hard, I can get through to even the most difficult or unmotivated students.

Teacher Efficacy (cont.)	If a student did not remember information I gave in a previous lesson, I would know how to increase his/her retention in the next lesson. I feel comfortable using the computer as a demonstration tool in class. I can easily use the computer to simulate events for the classroom my students cannot otherwise experience. When in class, my students use the computer as a tool to exchange information with others. If a student did not know how to use a certain computer program we were using, I would know how to teach him/her the basic operations of the program. Parents should be the ones to teach their children about how to use computers.
Perceived Ease of Use	My interaction with the technology is clear and understandable. It is easy for me to become skillful at using these technologies in the classroom. I find these applications and technologies easy to use in the classroom. I find it easy to get these applications, programs and technologies to do what I want them to do.
Perceived Usefulness	Using Web 2.0 applications and other computer technologies enhance my effectiveness as a teacher. Using Web 2.0 applications and

Perceived Usefulness (cont.)	other computer technologies increase my productivity as a teacher. I find these Web 2.0 applications and other computer technologies useful for my job as a teacher.
Perceived Media Richness	These technologies allow me to: Tailor messages to my own personal requirements. Communicate a variety of different information or cues (attitude or tone) in my messages. Use rich and varied language in my messages.
Use Richness	I use these technologies to convey multiple types of information in the classroom to teach students. **I** make rich and varied use of these technologies in the classroom to teach students. I adapt my use of these technologies in the classroom depending on which class or subject I am teaching. I make use of multiple computer applications or programs at once to illustrate a lesson.

Appendix B: Figures

		Constructivist Belief Profile	Perceived Media Richness
Constructivist Belief Profile	Pearson Correlation	1	.427**
	Sig. (2-tailed)		.003
	N	46	45
Perceived Media Richness	Pearson Correlation	.427**	1
	Sig. (2-tailed)	.003	
	N	45	56

**. Correlation is significant at the 0.01 level (2-tailed).

Figure B1. Pearson Correlation Coefficient between the variables of constructivist teacher belief profile and perceived media richness.

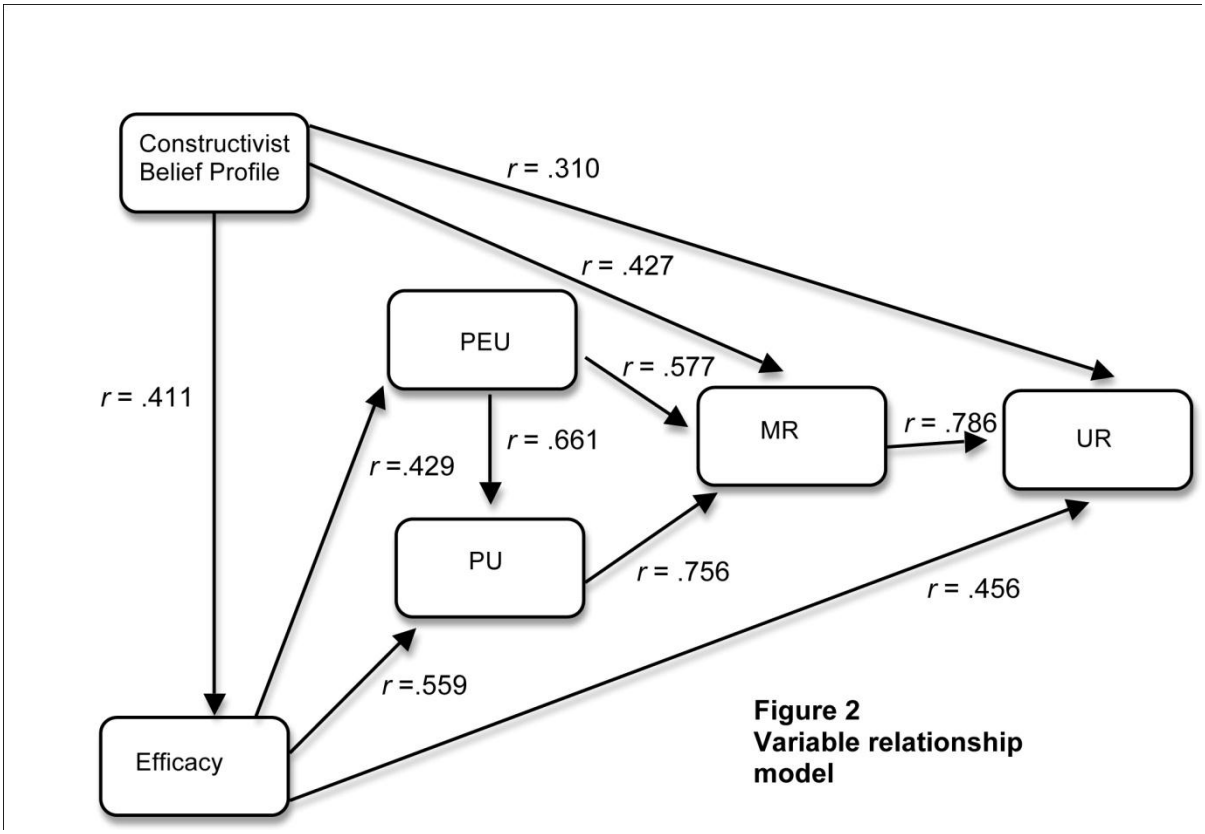

Figure B2. Variable relationship model